STEEL

Project Fact Sheet

Improved Refractories Using Engineered Particles

Benefits

- Reduces refractory cost per ton of steel through improved refractory longevity and performance
- Increases thermal shock resistance over conventional refractory materials
- Improves steel quality by reducing refractory inclusion content
- Achieves higher strength and toughness than current industry standard refractories
- Increases oxidation resistance of refractories
- Allows use of low density and modulus fillers as encapsulated microballoons

Applications

This technology is designed specifically for use in steel production. The surface-improved refractory particles and fillers would be used as raw materials for both castable and brick refractories. In particular, the improved refractories are applicable in steel ladles, where they help to overcome traditional ladle refractory problems. Engineered particle refractories are especially important in improving the performance and reducing the cost of the particularly complex ladles used for ladle refinement, microallying, and continuous casting, which represent an increasing percentage of steel production activities.

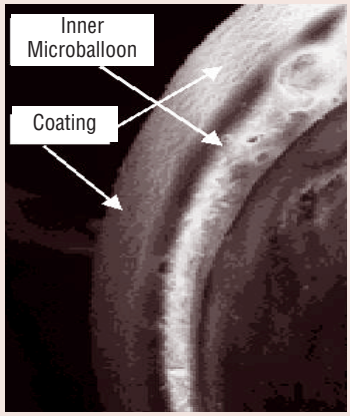
Newly engineered particles create steel manufacturing refractories with increased resistanace to thermal shock, better durability, and greater oxidation resistance

Refractories are heat-resistant materials used to line furnaces and containers employed in steel production processes. Refractories must withstand not only temperatures in excess of 1600°C, but also severe thermal shock, erosion, corrosion, and oxidation. The longevity and performance of refractories under these conditions impacts process economics, production capacity, steel quality, and safety.

Typical refractories are constructed from burned oxides of alumina and mullite (aluminosilicate). Carbon is added to improve durability and wear characteristics, but these carbon-impregnated refractories are damaged by erosion and carbon oxidation, and they experience cracking and fracture caused by thermal shock.

A new technology alters conventional formulations to create improved refractories using specifically engineered alumina-carbon and mullite-carbon refractory aggregate particles. These engineered particles are created by applying uniform carbon and carbide coatings to alumina particles and mullite microballoons. Fine alumina/graphite/mullite sintering aids are then added to produce a refractory particle with a controlled microstructure. These particles can be cast or sintered into a refractory component that provides improved wear, erosion, thermal shock, and oxidation resistance.

Improved Refractories Using Engineered Particles



A low density filler, such as an Si-C mullite composite refractory, is used as an engineered micro balloon filler for refractory mixes to increase toughness and thermal shock resistance in refractories used in the steel industry.

Project Description

Goal: Demonstrate the ability to produce longer-life, tailored refractories for steel ladles through designing and producing engineered particles.

Engineered particles are created using a fluidized-bed coating technology to produce controlled carbon deposits on alumina and mullite microballoons. The adherence and oxidation resistance of the carbon coatings are improved through the addition of interlayers of silicon, titanium, boron, and rare earth, or through the use of titanium/nitride coatings as a substitute for carbon. The particles are combined with alumina/graphite/mullite sintering aids fines to produce a refractory particle that can be cast or sintered into a refractory brick or component. In this process, uniform distribution of small amounts of chemical modifiers and additives onto microballoons and large particles potentially provides significant increases in refractory life and performance.

Compared to current alumina/carbon refractories, the improved engineered refractories exhibit increased resistance to wear, erosion, thermal shock, and oxidation. Higher strength and toughness are also achieved through controlling the microstructure bonding and uniformity. Additionally, the encapsulated micro balloon approach allows the use of low density and modulus fillers by eliminating fracture of these fragile materials, allowing them to be blended with carbon black and fines.

Powdermet, Inc., is developing this new technology with the help of a grant funded by the Inventions and Innovation Program in the Department of Energy's Office of Industrial Technologies.

Progress and Milestones

- Characterize alumina particles and aluminosilicate micro balloon materials and determine coating deposition parameters.
- Investigate adhesion and oxidation resistance of the coated particles.
- Manufacture test quantities of the six top engineered particle systems.
- Cast test refractory bricks and bars from the top six engineered particle systems.
- Characterize the microstructure and physical properties of the refractories prepared.
- Develop a cost model for the refractory materials produced in the project.

Economics and Commercial Potential

The potential for energy, economic, and environmental savings and performance improvements associated with the improved refractories using engineered particles is significant. Engineered refractories would improve ladle refining, metal transfer, and tundish designs, as well as reducing steel loss from ladle leaks and decreasing the formation of slag. Reducing ladle leakage and slag formation during transfer operations by just 2 percent would result in an equivalent energy savings of 10 kilowatt-hours per ton of steel produced.

The total domestic market for refractories is estimated to be over $2.3 billion, with steel refractories ladle/tundish operations representing roughly $600 million per year. Approximately 50 percent of this value is in raw materials, with a potential 20 percent market share for the improved engineered particles, translating to a market of 60 million pounds per year representing $120 million in potential revenue.

Industry of the Future—Steel

Through OIT's Industries of the Future initiative, the Steel Association, on behalf of the steel industry, has partnered with the U.S. Department of Energy (DOE) to spur technological innovations that will reduce energy consumption, pollution, and production costs. In March 1996, the industry outlined its vision for maintaining and building its competitive position in the world market in the document, ***The Re-emergent Steel Industry: Industry/Government Partnerships for the Future.***

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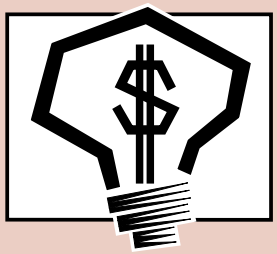

The Inventions and Innovation Program works with inventors of energy-related technologies to establish technical performance and conduct early development. Ideas that have significant energy savings impact and market potential are chosen for financial assistance through a competitive solicitation process. Technical guidance and commercialization support are also extended to successful applicants.

Project Partners

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DOE/GO-102001-1027
Order# I-ST-766
February 2001